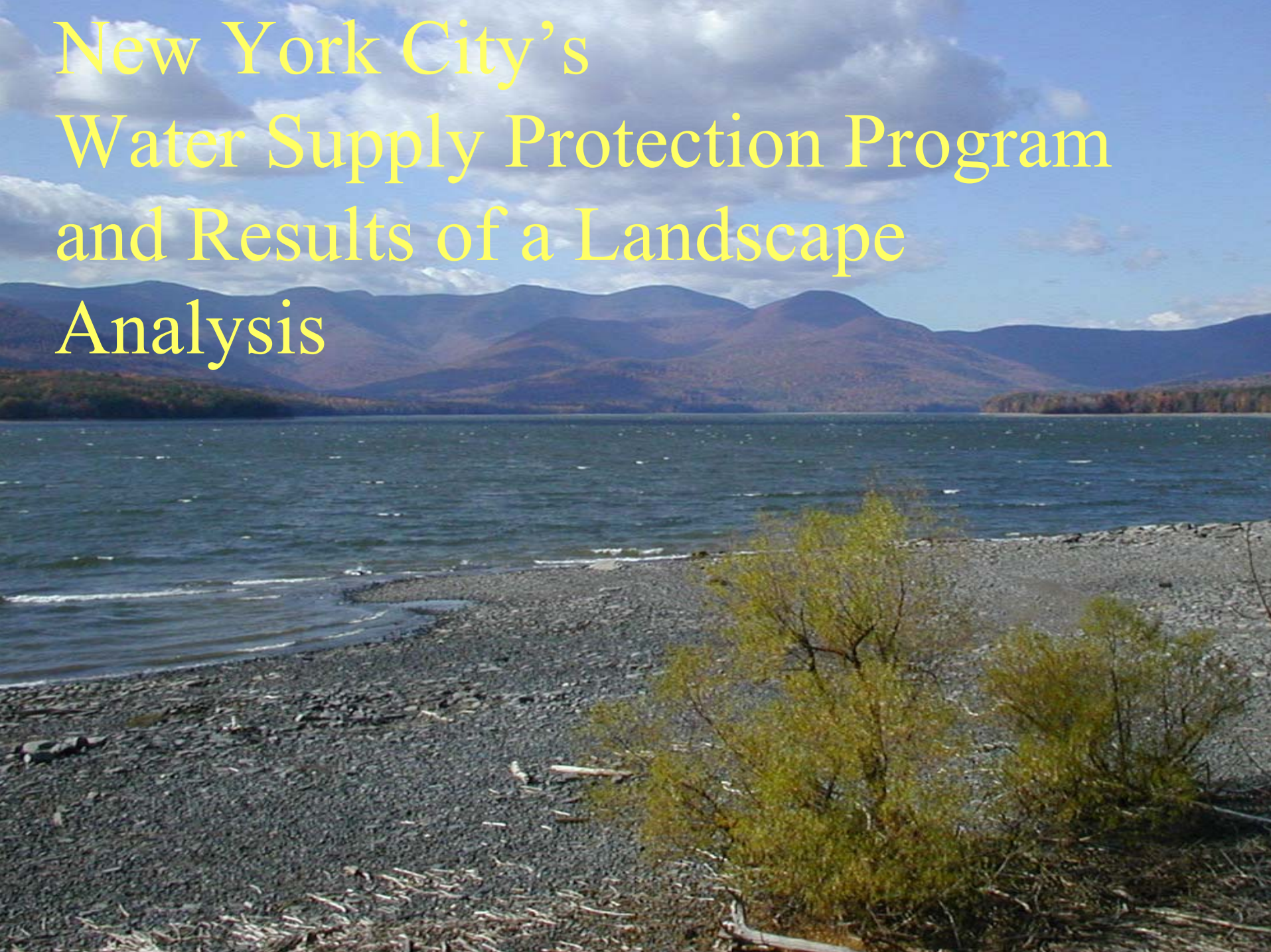


New York City's Water Supply Protection Program and Results of a Landscape Analysis

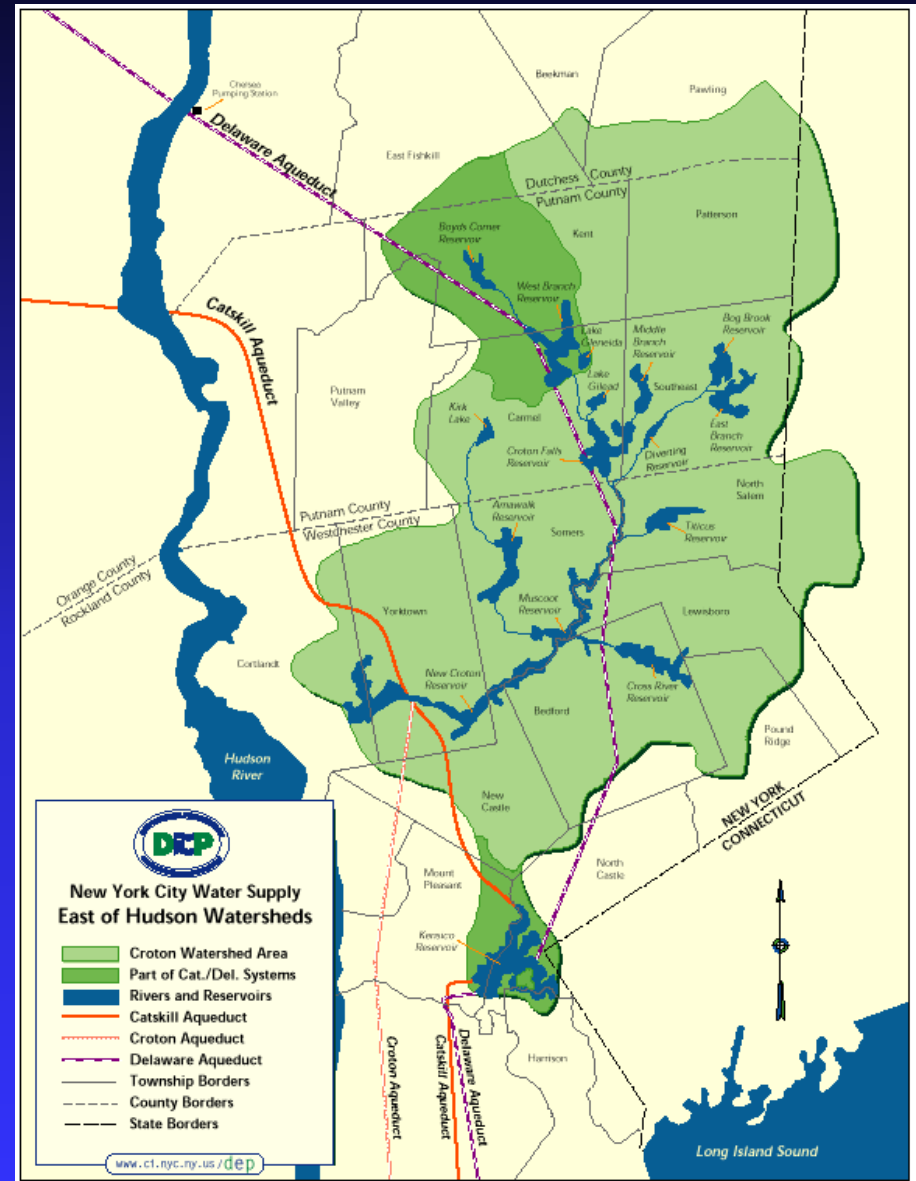




- ◆ Supplied by three upstate watersheds covering 1950 sq. miles
- ◆ 19 reservoirs
- ◆ Storage capacity of 600 billion gallons
- ◆ Serves 9 million people an average of 1.4 billion gallons/day
- ◆ 90% from Catskill Delaware system
- ◆ 95% delivered by gravity
- ◆ Currently only water coming from Croton must be filtered

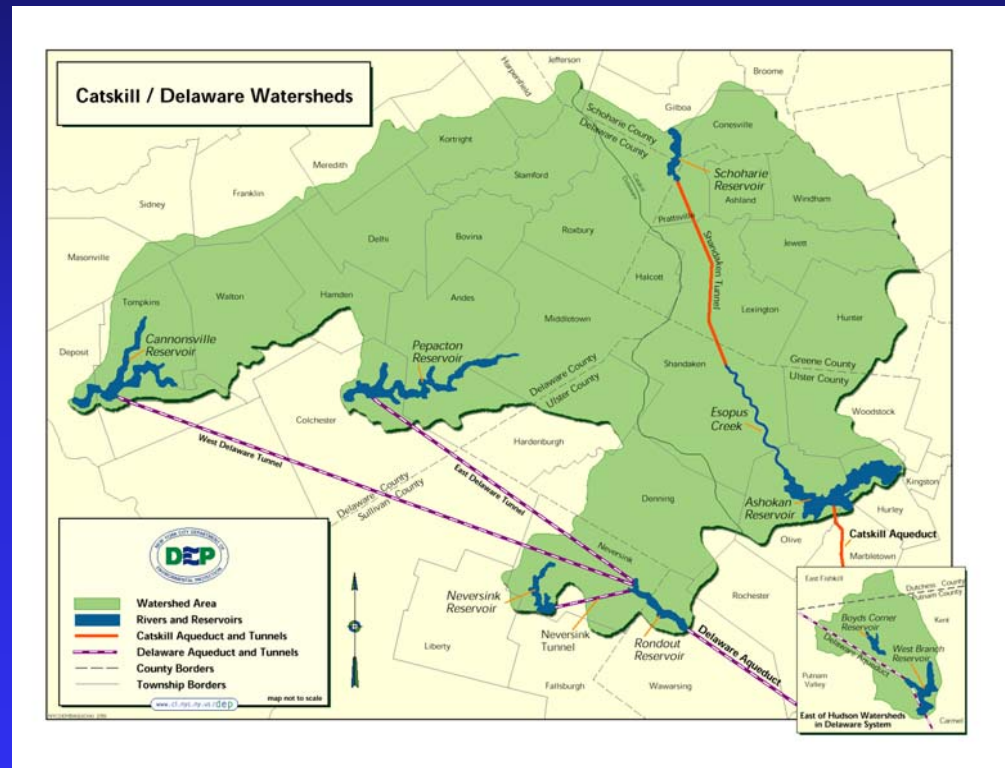
Croton

- ◆ Source water indicates stress
- ◆ Elevated disinfection byproducts
- ◆ Not used periodically
- ◆ High density and high growth
- ◆ Close to City
- ◆ Inflexible system
- ◆ Must be filtered



Catskill/Delaware

- ◆ Excellent source water
- ◆ Low levels of disinfection byproducts
- ◆ Low density and low growth
- ◆ 75-125 mi from City
- ◆ Flexible system
- ◆ Currently no filtration required



EPA's Role in City's Water Protection Program

- Mandate is through Safe Drinking Water Act and specifically Safe Water Treatment Rule
- Requires that all drinking water taken from surface water be filtered to remove microbial contaminants
- A filtration waiver can be granted if a strict series of water quality, operational, and watershed control criteria can be met.
- Filtration Avoidance is the exception to the rule

Surface Water Treatment Rule

■ Source Water Quality Criteria

- ◆ Coliforms
- ◆ Turbidity

■ Site-Specific Criteria

- ◆ Disinfection
- ◆ Absence of waterborne disease outbreaks
- ◆ Total coliform MCLs
- ◆ Total trihalomethane MCLs
- ◆ Watershed Control

1997 Filtration Avoidance Determination – Program Elements

- Objective criteria compliance
- Land Acquisition
- Agricultural Program
- Infrastructure
 - ◆ Septic systems
 - ◆ Wastewater Treatment Plant Upgrade program
 - ◆ Stormwater controls
- Waterfowl management
- Forestry Program
- Wetlands protection
- Kensico program
- Monitoring/Modeling/GIS
- Watershed Rules & Regs
- WWTP inspection program
- Disease surveillance
- Cross connection controls
- Education and Outreach
- Stream management

Land Acquisition Program

- In 1997, City owned only 7% of watershed land
- Land ownership is the best means of protecting water quality
- Requirements:
 - ◆ Solicit 355,050 acres – vacant land from willing seller
 - ◆ Prioritized by proximity to reservoirs and distribution system
 - ◆ \$300 million commitment over 15 years

Land Acquisition Program



Agricultural Program

- 350 dairy farms in watershed (gross > \$10,000)
- Potential source of pathogens and nutrients to source water
- Voluntary locally-led program with 100% funding by NYC
- Objective – improve water quality through multi-barrier approach:
 - ◆ Source control
 - ◆ Transport reduction across farm
 - ◆ Prevention of contaminant deposition in watercourses

Agricultural Program Activities

- Over 90% participation
- Prioritized management practices
- Conservation Reserve Enhancement Program (CREP)
- Small farm program
- Agricultural easements
- Research
- Forestry Program

Looking Ahead

- Move from implementation to evaluation
- Continue to modify and enhance programs
- Improve relationship between City and upstate communities
- Ensure continued compliance with EPA's filtration avoidance determination

Results of a Landscape Analysis

A 25 Year Landscape Analysis of the Catskill/Delaware Watersheds

M.H. Mehaffey, M.S. Nash, T.G.
Wade, C.M. Edmonds, D.W. Ebert,
A. Rager, and K.B. Jones



Biophysical Setting of the Watersheds

Elevation



Elevation (meters)

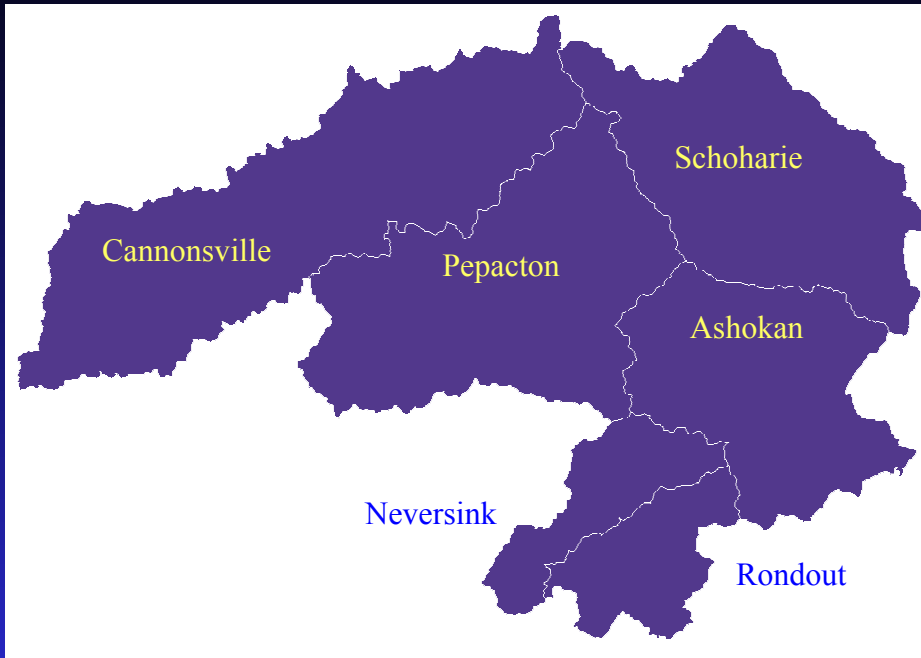
125 - 220
221 - 316
317 - 412
413 - 508
509 - 604
605 - 700
701 - 796
797 - 892
893 - 988
989 - 1084
1085 - 1180
1181 - 1276

Biophysical Setting of the Watersheds

Land Cover/Use



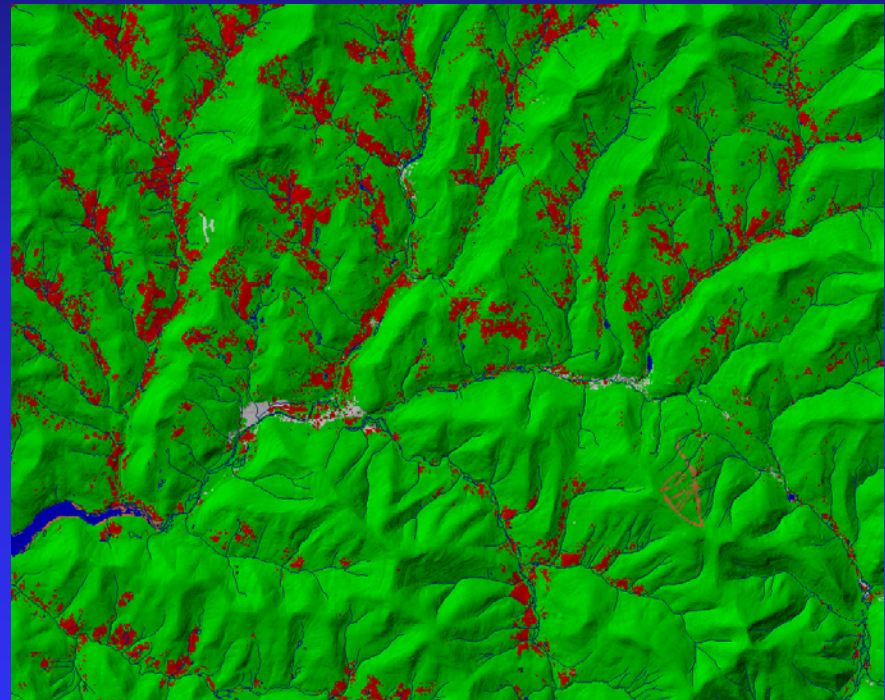
Land Cover by Watershed



Watershed	Forest	Urban	Agriculture	Barren
Cannonsville	75.3	0.48	23.9	0.28
Schoharie	89.2	0.24	10.3	0.28
Pepacton	87.0	0.16	12.7	0.12
Ashokan	98.6	0.36	1.0	0.07
Neversink	97.8	0.07	2.1	0.11
Rondout	95.9	0.12	4.0	0.00

Riparian Land Use/Cover

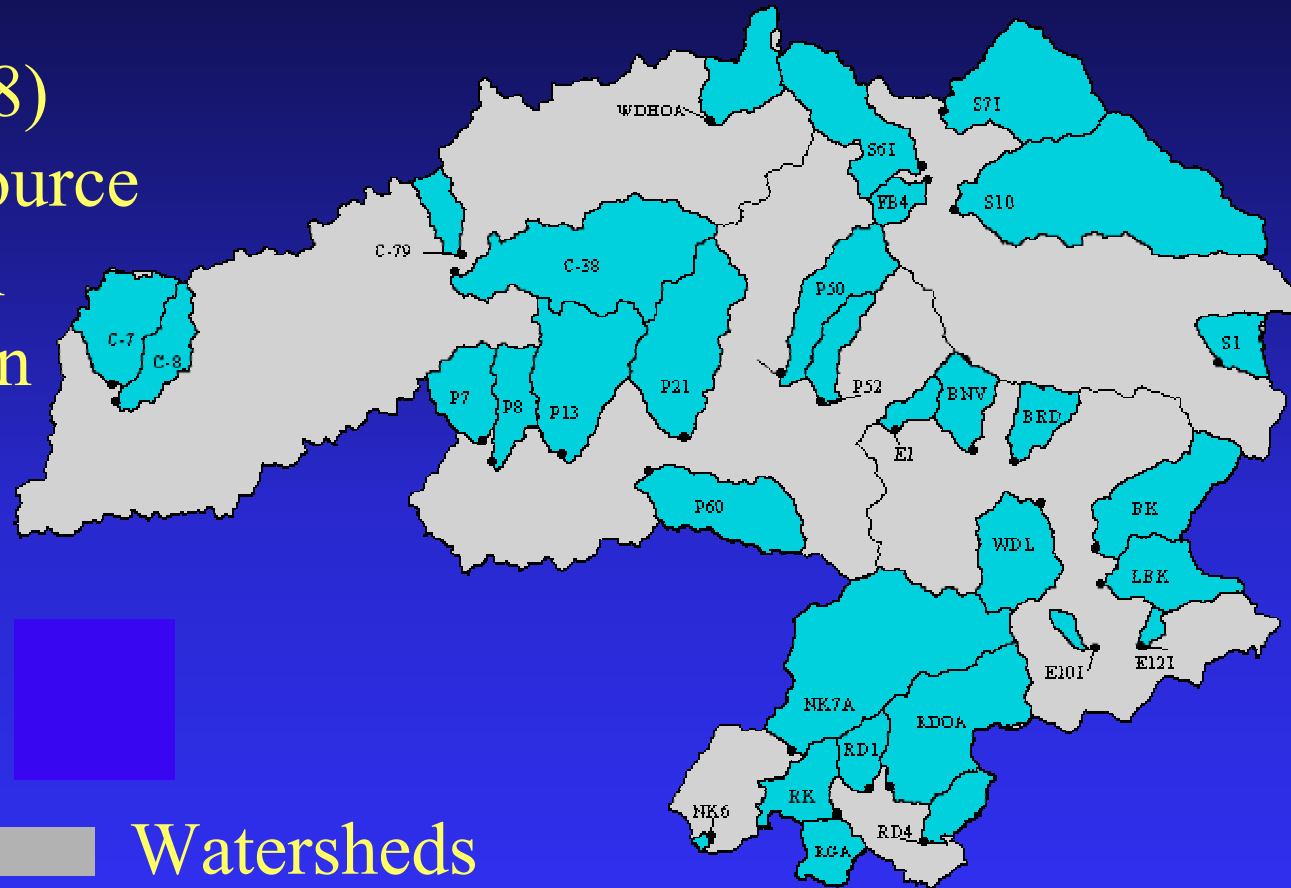
- Up to 80 percent of the sub-watersheds total agriculture is located within 120 m of streams.
- Riparian forest cover slightly lower than in whole watersheds.
- Percent forest cover did not change between 30 and 120 meter buffer size.



Water Quality Sample Sites

Site Selection

- Data (1987-1998)
- No near point source
- Off main stream
- Even distribution
 - ◆ Across area
 - ◆ Across Land Cover Type

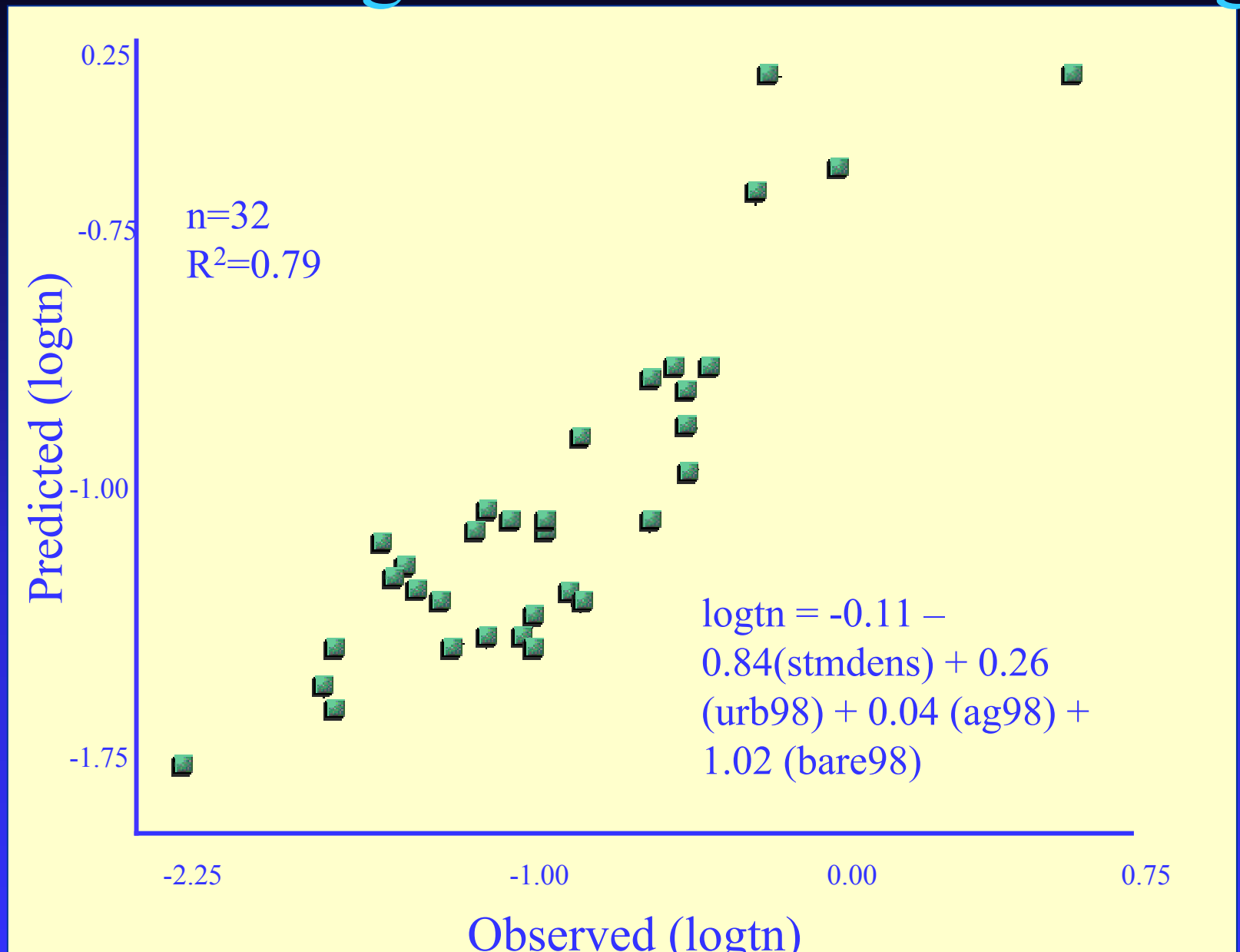


- Watersheds
- Delineated Sub-watersheds
- Water Sample Site

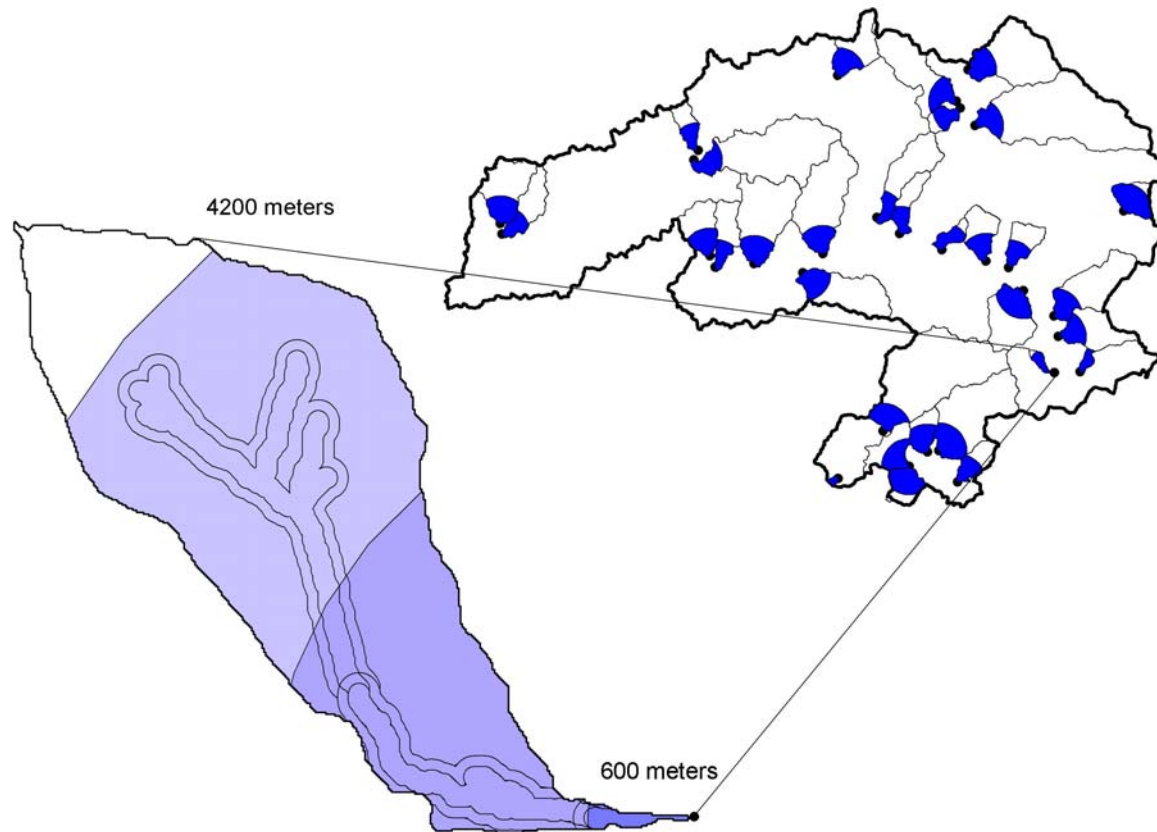
Results of Multiple Regression

		1987		1991		1998	
		<i>B</i>	Partial R ²	<i>B</i>	Partial R ²	<i>B</i>	Partial R ²
Log N	StreamDensity			- 0.921			
	Agriculture			0.046	59.3	0.039	64.9
	Developed			0.312	6.2	0.256	4.0
	Ag. on Erodible Soil			-0.182	4.3		
	Barren					1.018	3.0
Model R ²				79.4		79.1	
Log P	StreamDensity			- 0.574	3.0	-0.928	7.0
	Agriculture	0.052	50.5	0.047	69.5	0.032	43.1
	Developed			0.233	4.3	0.362	5.4
	Ag. on Erodible Soil					0.426	7.6
Model R ²		50.5		76.8		63.2	
Log FC	Erodible Soil	0.271	16.6	0.206	8.5	0.132	3.3
	Developed	0.409	15.9	0.428	10.5	0.389	12.2
	Agriculture	0.043	31.0	0.048	48.4	0.046	12.7
	Ag. on Slopes >15%			1.099	5.1	1.494	46.1
Model R ²		63.5		72.4		74.3	

Results of Regression for Total Nitrogen



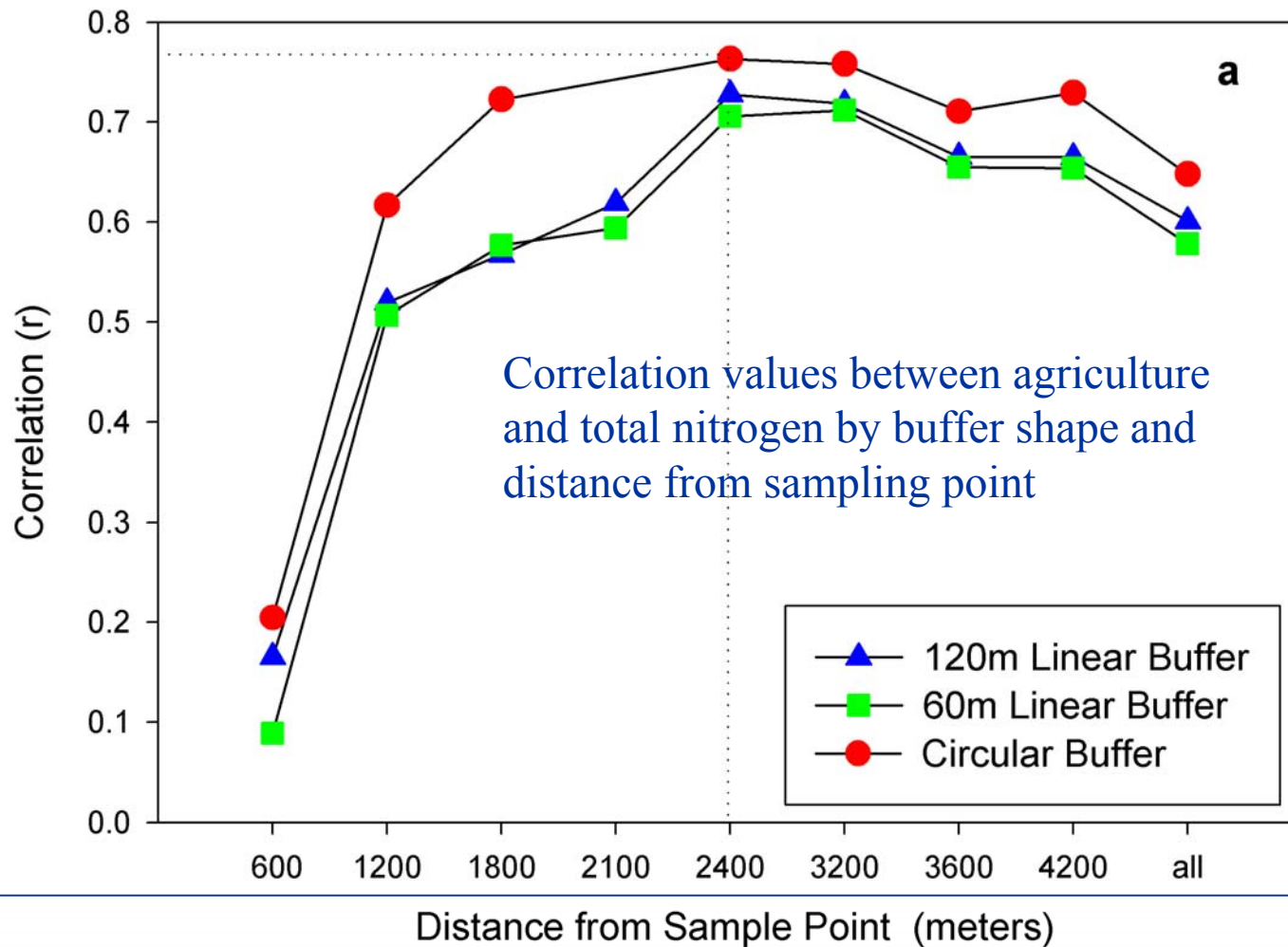
More Landscape Analysis



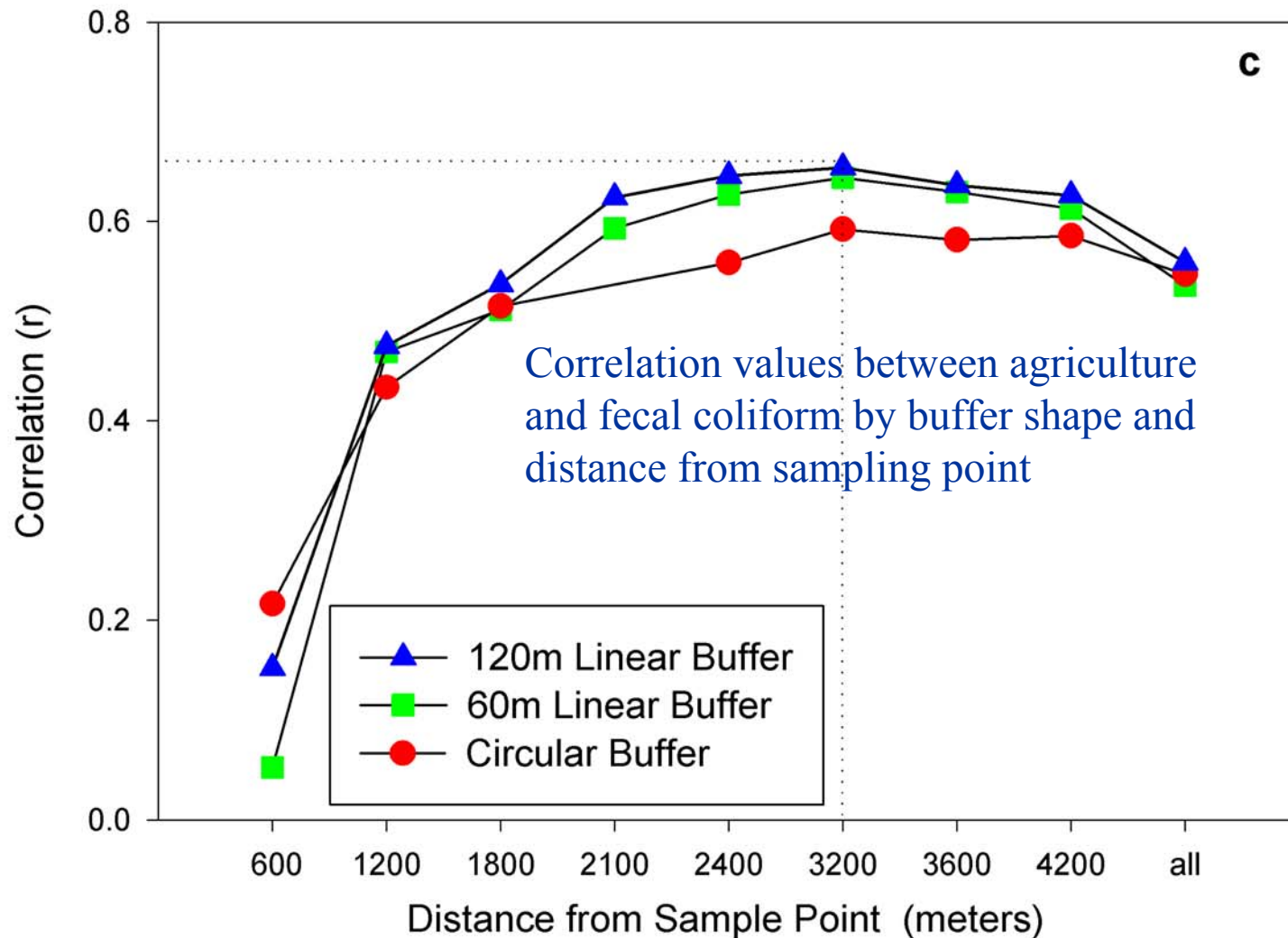
Location of watersheds used in the analysis and the circular and 60m and 120m linear buffers used to determine the effective area of influence (EAI).

Source: **Determining Landscape Metrics Effective Area of Influence on Water Quality**
M.H. Mehaffey, M.S. Nash, T.G. Wade, and D.W. Ebert. Paper submitted to Landscape Ecology

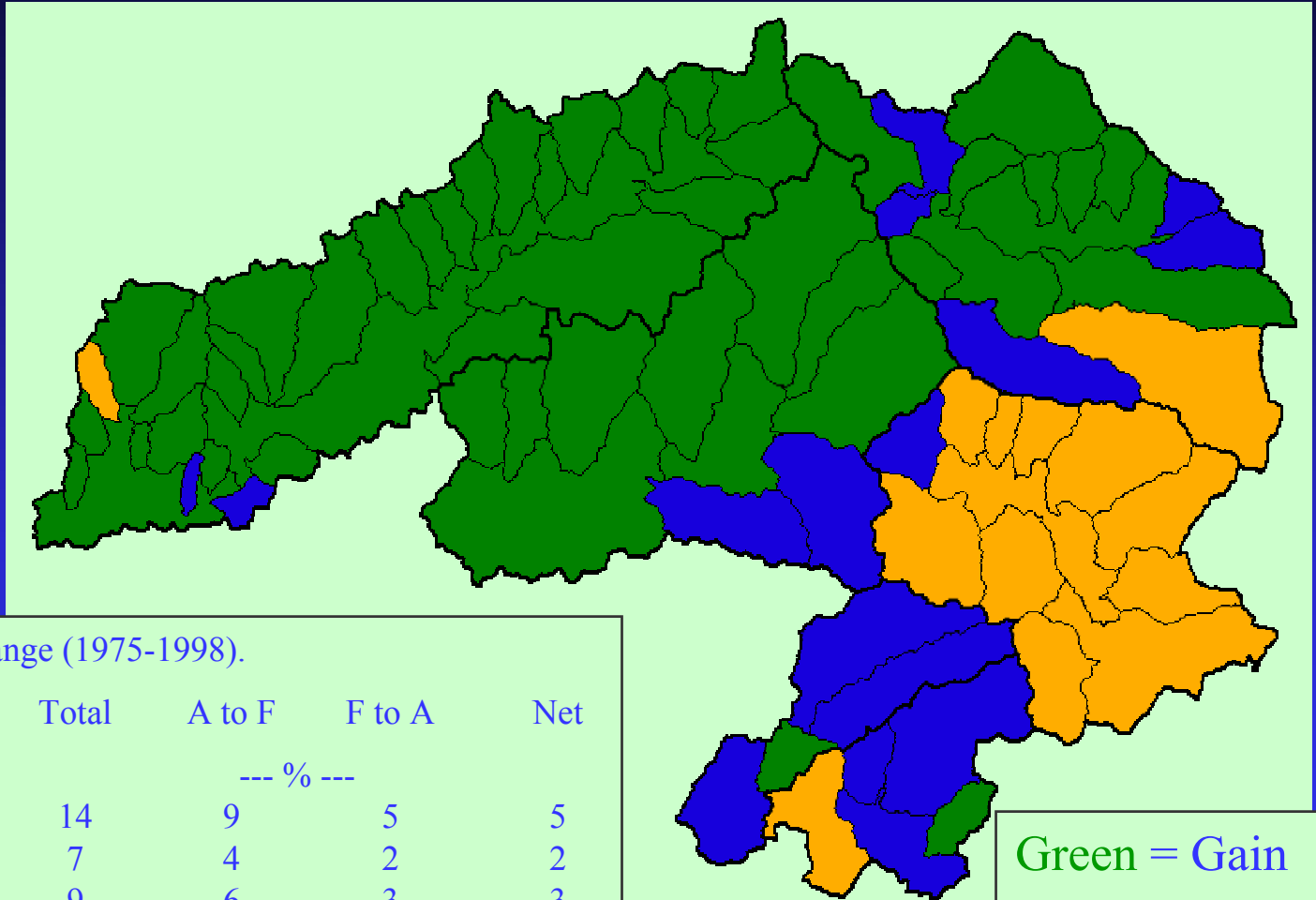
More Landscape Analysis



More Landscape Analysis



Land Cover Change (1975-1998)



Land Cover Change (1975-1998).

Watershed	Total	A to F	F to A	Net
--- % ---				
Cannonsville	14	9	5	5
Schoharie	7	4	2	2
Pepacton	9	6	3	3
Ashokan	1	0	1	-1
Neversink	2	1	0	1
Rondout	3	2	1	1

Green = Gain

Blue = No Change

Orange = Loss

Conclusion of Landscape Analysis

- Landuse gradient from NW to SE.
- Majority of agricultural land use located within 120m of streams.
- Land cover change has been minimal, greatest amount in Cannonsville.
- Vegetation shifts have been between forest and agriculture.
- 3/4 variability in surface water quality parameters explained by landscape metrics.
- Decreasing contribution of agriculture to surface water nutrient concentrations over time.

Conclusion of Landscape Analysis as it Relates to Watershed Protection Program

- Allows watershed managers to see quantitatively what they already suspected intuitively.
- Provides another tool for watershed managers to effectively assess risks in the watershed.
- Supports the belief that appropriate watershed protection programs are being implemented by NYC.